MAAMACARE - AN AI-ENABLED MOBILE COMMUNICATION SYSTEM TO SUPPORT MATERNAL HEALTH, CASE STUDY: CHURCH OF UGANDA MUKONO HOSPITAL

EMMANUEL KALYEGIRA

M23B13/005

DANIELLA MWIZA

M23B13/055

DOMINIC MUHAIRWE

M23B13/024

KEVIN KIVUNA

M23B13/094

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UGANDA CHRISTIAN UNIVERSITY

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DECLARATION

We, the undersigned, hereby attest to the originality and authenticity of this report, MaamaCare. It stands as the culmination of our diligent research and analysis, undertaken with unwavering dedication. This report has not been presented elsewhere, nor has it been subjected to evaluation or recognition by any other agricultural entity or academic institution. Our collective efforts have been invested in crafting a comprehensive document that unveils insights and strategies to enhance connectivity and efficiency within the health sector.

EMMANUEL KALYEGIRA
Signature: Date: 18th April

MWIZA DANIELLA
Signature: Date: 18th April

DOMINIC MUHAIRWE
Signature: Date: 18th April

KIVUNA KEVIN
Signature: Date: 18th April

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APPROVED BY: SUPERVISORS

Signature: 
Date: 05/25/2026
Name: Ms Justine Mukalere

Signature: 
Date: 30/04/2026
Name: Dr. Bitalo Daphne

Signature:
Date:
Name: Mr. Opio Solomon

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List of Abbreviations

AI	Artificial Intelligence
ANC	Antenatal Care
EMR	Electronic Medical Records
mHealth	Mobile Health Technologies
SDG	Sustainable Development Goal
SMS	Short Message Service
UTI	Urinary Tract Infection
WHO	World Health Organization
UNFPA	United Nations Population Fund
VHT	Village Health Team

1 ABSTRACT

Maternal mortality remains a major public health challenge in Uganda, particularly in rural and peri-urban communities where access to maternal health information and follow-up care is limited. Many pregnant mothers rely on basic feature phones, which restricts access to smartphone-based maternal health applications. This project developed MaamaCare, an AI-powered SMS maternal health support system designed to improve communication between healthcare providers and pregnant mothers while delivering timely maternal health education and antenatal care reminders.

The system integrates an automated SMS communication engine, an AI-powered maternal health assistant, and a web-based hospital monitoring dashboard. It was developed using an Agile iterative development methodology, enabling incremental development and testing of system components. Technologies used in the implementation include FastAPI for backend services, Supabase for database management, OpenAI API for the AI assistant, and Africa's Talking SMS gateway for message delivery.

Testing of the developed prototype confirmed that the system successfully sends automated SMS health messages, allows interaction with the AI assistant through the mother dashboard, and enables healthcare workers to monitor maternal communication through the hospital dashboard. However, the system was evaluated in a controlled development environment and has not yet been deployed in a real hospital setting.

The results demonstrate that combining SMS communication with artificial intelligence can improve access to maternal health information in low-resource envi ronments. The MaamaCare system provides a foundation for future improvements, including real-world pilot testing, expanded language support, and enhanced two-way communication with mothers.

2 INTRODUCTION

Maternal mortality continues to be a significant public health issue in Uganda. The World Health Organization (2025) states that most of the preventable maternal deaths directly result from the inability to get quality healthcare on time and poor health education. Even though the government has set up national policies and increased awareness campaigns, a lot of pregnant women, particularly in rural and peri-urban areas, are still facing challenges in accessing the proper services for antenatal care (ANC) and safe delivery, as a result, they are still suffering from complications and dying due to lack of medical attention.

The use of mobile technology is one of the most effective ways to distribute healthcare information. However, DataReportal (2024) points out that smartphone use in Uganda is still quite limited primarily to urban areas; most of the people that own smartphones have them as a secondary phone, while the main phone is a basic feature one. There is a digital split between the urban and the rural people that impedes the rural area people to benefit from modern health apps, which in turn, leads to disparities in health outcomes.

Research has indicated that employing the right communication technique in the right language helps to a great extent in maternal health education (UNFPA, 2016; IDRC, 2025). Using artificial intelligence (AI) via SMS is an innovative yet a very inclusive way of sending real-time health information to expecting mothers who do not have internet or smartphone access. Such initiatives have the potential of connecting hospitals with mothers early enough to detect complications, thus, ensuring correct ANC adherence and providing authoritative data for healthcare professionals to make their decisions.

This report documents the development, implementation, and evaluation of an AI-based mobile communication system "MaamaCare" designed and adapted for Mukono Church of Uganda Hospital. The system was built to send and receive pregnancy-related information via SMS in a timely and localized manner, while also supporting hospital specialists with an intelligent dashboard for case management and analytics.

2.1 Background of the Study

Mukono Church of Uganda Hospital serves urban and rural populations through its health services. The hospital has many patients in the maternity ward and has limited resources to adequately care for the mothers and children after their discharge from the hospital. Because of the high volume of patients and the limited resources, these mothers often do not receive proper follow-up care and do not communicate properly with the facility about their health.

As part of the team’s fieldwork with the hospital, we met with health workers from the hospital and learned that record management within the hospital involves both paper and electronic means (EMRs). However, the records are maintained in a hybrid system, which results in duplication of effort and improper entry or loss of data. The majority of the hospital’s communication with the mothers is performed using telephone conversations; therefore, staff members are required to

spend a substantial amount of time making these calls and providing mothers with the same information repeatedly.

Our research findings revealed several critical challenges:

(i) Limited understanding of medical advice among mothers, especially those with low literacy.

(ii) Missed or delayed antenatal visits due to poor follow-up mechanisms.

(iii) Overburdened health staff performing repetitive administrative and communication tasks.

(iv) Lack of automated triage mechanisms to detect high-risk maternal symptoms.

These findings underscored the need for a system supporting two-way communication between mothers and healthcare providers. The proposed solution integrated AI-powered SMS features with a hospital dashboard to enable real-time monitoring, case escalation, and data analytics.

2.1.1 Global Perspective

Maternal mortality in the world is still a non-ignorable problem, and it is very much so in low and middle-income countries (LMICs). The number of maternal deaths worldwide has come down considerably over the last few decades; however, the gains are not uniform across the board and many nations are still far from the safe motherhood goals. Mobile health (mHealth) interventions have been introduced and tested as means of increasing MNCH benefits by strengthening ANC attendance, postnatal care, and information distribution. Systematic reviews and meta-analyses reveal that mHealth interventions have a marked effect on the increase of ANC and postpartum care visits among pregnant women in LMICs (Chan Zhang, 2022; Lee et al., 2021). However, there is a lack of consensus and clear evidence on whether mHealth interventions bring about long-lasting changes in related areas such as maternal or neonatal mortality, hospital births, or behavioral change regarding the latter leading to the need for implementing methods that are specific to the context and that consider the local limitations.

2.1.2 Regional Perspective(Africa)

Sub-Saharan Africa faced high rates of maternal mortality, while the increasing adoption of mobile phones provided health companies with a unique opportunity to develop targeted health solutions. Many mHealth interventions were initiated across Africa aimed at upgrading maternal and perinatal care, with early results proving encouraging. Tools deployed at the community level supported antenatal, birth, and postnatal care tracking, appointment reminders, and referral facilitation. Nonetheless, success was affected by infrastructural limitations, low digital literacy, and challenges in sustaining services after pilot funding ended. Under these conditions, mHealth solutions using basic phone features such as SMS, which depended less on data or internet, demonstrated greater adoption and impact (Sondaal, S. F. V. 2017).

2.1.3 National Perspective(Uganda)

Uganda continued to record high maternal mortality rates, driven by limited access to quality care, particularly in rural and underserved areas, as well as information gaps linked to socioeconomic status and literacy levels. mHealth interventions in Uganda demonstrated feasibility and acceptability even among pregnant women with low literacy. A pilot study in rural southwestern Uganda (Atukunda, E. C., 2021) found that women using a multimedia mobile phone-based application reported SMS and audio reminders as effective in motivating clinic attendance. The randomized SupportMoms-Uganda project similarly demonstrated that customised SMS and audio messaging resulted in increased ANC attendance and uptake of maternity services among rural women. These results supported the viability of mobile phonebased maternal health interventions in Uganda, while highlighting the structural reality that most mothers owned only basic feature phones or had irregular access to devices and power.

2.2 Problem Statement

Although there are already maternal health programs and guidelines in place, according to Uganda Ministry of Health's 2024/25 Annual Health Sector Performance Report, about 44% of pregnant women in Uganda attend less than four antenatal visits. The low attendance rate is one of the factors that lead to the occurrence of complications and deaths, which are, however, preventable. The lack of access to the timely delivery of health information is the main reason for this gap, particularly in the case of women who do not have smartphones or internet access.

The communication with pregnant women at Mukono Church of Uganda Hospital is mostly done manually and in an unstructured manner, which leads to the unacceptability and postponement of emergencies response. There is no digital system that links the communication records of mothers to the clinical data or provides automated health education. As a consequence, inefficiencies, data loss, and delays in triaging high-risk cases have emerged.

2.3 Objectives of the Study

2.3.1 Main Objective

To design and develop an AI-powered SMS based maternal health communication system for Mukono Church of Uganda Hospital to improve maternal health awareness, communication efficiency, and data-driven clinical decision-making.

2.3.2 Specific Objectives

(i) To evaluate existing communication workflows and challenges in maternal care for the Mukono Church of Uganda Hospital.

(ii) To design an AI-based system capable of delivering health tips and reminders through SMS in local languages.

(iii) To develop a hospital dashboard that enables health specialists to manage escalated cases, monitor trends, and analyze maternal health data.

(iv) To ensure secure and reliable data management by integrating communication records with hospital systems.

(v) To evaluate the feasibility and user acceptance of the AI-powered communica tion system among healthcare staff and pregnant mothers.

2.4 Scope of the Study

2.4.1 Technical Scope

The system comprised of three main components:

(i) An AI communication engine for sending automated SMS messages.

(ii) A two-way communication interface for pregnant mothers using basic feature phones.

(iii) A web-based hospital dashboard for managing cases, generating reports, and analyzing maternal data.

2.4.2 Geographical Scope

This study was centred around Mukono Church of Uganda Hospital located in Mukono District, Uganda. The system was primarily designed for the facility's maternity ward, with the architecture designed to be scalable to other healthcare settings within similar environments.

2.4.3 Content Scope

The focus of the project is on maternal health education, reminders for antenatal visits, identification of danger signs at an early stage and escalation pathways for cases, It does not include features associated with advanced Clinical Diagnosis and Treatments.

2.5 Justification of the Study

Maternal mortality continues to be an unacceptably high in Uganda as a result of challenges faced regarding Communication, Access to Healthcare and Health Literacy. The new system will bridge those gaps by providing low-cost easy access to accurate, culturally appropriate information on Maternal Health, sent via SMS using AI.

Since most rural Uganda women use basic mobile phones (DataReportal, 2024), this method will support inclusiveness and sustainability. By providing a solution that works within the hospital's current technology, the system will improve operational efficiencies and provide data to make informed decisions for mothers' care. Additionally, mothers will benefit by receiving educational material to assist them in making informed health decisions, building a stronger relationship with the hospital/healthcare providers while assisting them in reducing preventable maternal and neonatal deaths.

3 LITERATURE REVIEW

Mukono Hospital is located in the central part of Uganda, Mukono District, and is a hospital operated by a branch of the Church of Uganda (Diocese of Mukono). It has been in operation since the early 1990's and was established to provide health care for the local residents. Mukono Hospital provides a a lot of health services that include maternal and child health, laboratory tests, outpatient care, and emergency services. Over the past ten years, the maternity department has experienced an increased number of maternity patients due to the growing population in both Mukono municipality and surrounding rural areas. The maternity department continues to face challenges related to staffing shortages, limited resources, and lack of effective means of communication between health providers and patients. The current system for managing patient records for Mukono Hospital is paper-based and partly an electronic medical records (EMR) system. Maternity care patients are typically seen first on paper and then converted to EMR. This can create inefficiencies and makes it possible for patient data to be lost. Health workers in the maternity unit outlined that follow-ups with pregnant mothers are usually through manual phone calls or in-person visits, and this takes a lot of time and effort.

3.1 Conceptual Review

The study's conceptual framework is based on the incorporation of AI into the maternal health communication systems. Among other things, AI has been recognized as a significant factor in the healthcare delivery process through the means of predictive analytics, automation, and personalization (Shatte et al., 2019). For instance, in Uganda which is characterized by a low-resource healthcare system, AI can be harnessed to the advantage of health workers by automating tedious communication, giving instant information as well as recognizing high-risk patients using symptom data.

The use of mobile technologies to support medical and public health practices is often referred to as mobile health (mHealth) interventions and these have really shown to be quite effective in enhancing the health of expectant mothers (WHO, 2023). Nevertheless, the majority of mHealth applications are designed for smart phone users with the internet thus limiting adoption in rural and semi-urban areas (Geldsetzer et al., 2020).

Owing to the use of AI-based SMS, the new system not only overcomes this barrier but also supports the claim that patient engagement and understanding are better when communication is through culturally adapted text (Mechael et al., 2019). The creation of a hospital dashboard also enables mothers to communicate with specialists which in turn leads to fast triage, monitoring, and analytics-based decision-making.

In conceptual terms, the system integrated three components:

(i) **AI Communication Engine:** Automates maternal education and reminders via SMS.

(ii) **Maternal Database and Dashboard**

(iii) **Analytics Layer:** Uses aggregated communication data to identify trends and high-risk conditions.

The framework supports the Sustainable Development Goal 3 (SDG 3) on reducing maternal mortality by improving access to reliable, timely information and quality care through technology.

3.2 Contextual Review (Preliminary Study)

The preliminary study conducted at Mukono Church of Uganda Hospital involved two health professionals from the maternity ward. The findings revealed that:

(i) Communication with mothers is mainly manually and mostly via phone calls.

(ii) Data entry duplication occurs between paper and EMR systems.

(iii) Mothers often misunderstand medical advice due to literacy and language barriers.

(iv) No automated mechanism exists for detecting emergency symptoms.

Readiness expressed by health care professionals regarding the implementation of AI-enabled tools is contingent upon those tools supporting, augmenting, and enhancing human decision-making rather than replacing it. Prior explorations of AI integration into healthcare systems have identified human oversight to be a critical component for improving efficiency through efficient use of AI (Haque et al., 2022). As a result of these findings, the hospital setting provides an exceptional opportunity to explore the impact of implementing an AI-driven system for automated maternal communication while maintaining a high standard of care delivery.

The evidence within the context supports the feasibility of implementing an AI-enabled telephone and SMS messaging platform to facilitate multiple languages within the same geographic region, improve the efficient management of medical records, and free up health professionals from performing repetitive tasks. The results of this exploration contributed to developing functional requirements and design considerations for the system discussed in the following chapter.

4 METHODOLOGY

A mixed-methods approach consisting of both qualitative and quantitative methods was used in this study. The qualitative aspect included structured interviews and field observations of maternity health workers at Mukono Church of Uganda Hospital, while the quantitative portion consisted of survey questionnaires used to gather quantifiable data on communication patterns, level of technology use/adoption, and rates of maternal follow-up.

The use of a rapid prototyping methodology was applied to implement a mobile phone-based self-management System designed for pregnant women. Rapid prototyping allows for the development of the application through multiple iterations of design and user feedback, with successive refinements made to the design and functionality. Each successive iteration of the rapid prototyping methodology will align with the objectives of the project.

This design allowed for a thorough understanding of current communication challenges and provided empirical grounding for system requirements and design. The integration of both methods supported triangulation, which improved the reliability and validity of the findings.

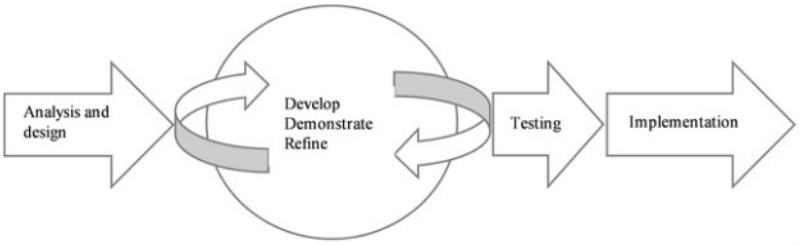


Figure 1: Rapid Prototyping Methodology Diagram

This design allowed for understanding of the current communication challenges and provided empirical grounding for system requirements and design. The inte gration of both methods supports triangulation, which improves the reliability and validity of the findings.

4.1 Relationship Between Objectives and Methodology

The selected methodology directly supports the achievement of the study objectives as follows:

(i) In order to evaluate the existing communication workflows and the challenges in maternal care for the Mukono Church of Uganda Hospital: The qualitative methodology consisting of structured interviews and field observations with maternity health professionals has been employed.

(ii) For the purpose of developing an AI-powered SMS communication system for pregnant mothers: The design phase of the system applies requirement analysis and iterative modelling to create a communication architecture that fits the reality of feature phone users.

(iii) For the development of a hospital dashboard for the purpose of monitoring and case escalation: The methodology is adopted which allows for incremental building of the system and continuous improvement.

(iv) For the testing and evaluation of the functionality and usability of the system: The system will go through staged testing that includes unit testing, integration testing, and user acceptance testing (UAT).

4.2 Data Collection Methods

(i) **Interviews:** Conducted with several maternity ward professionals to gather in-depth insights into existing workflows, communication challenges, and technology preferences.

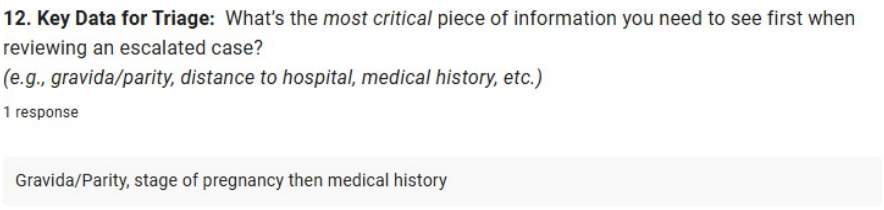


Figure 2: Sample response from midwives

(ii) **Questionnaire through Google Forms:** Distributed to collect quantitative data on communication frequency, time spent on follow-ups, and readiness for AI integration.

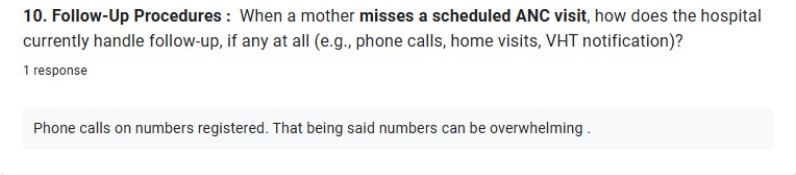


Figure 3: Sample form response from the questioned health specialists.

4.3 System Design and Development

4.3.1 System Analysis

The requirements for designing the system were determined based on field study findings gathered via participant questionnaire responses, which were analyzed with descriptive statistics to identify trends, similarities, and gaps. Qualitative interview responses were analysed thematically to identify recurring themes and patterns regarding perceptions of AIbased systems. Combining the two datasets allowed for the validation of both system requirements and user needs. Core components identified included:

(i) **AI Communication Module:** Automates outgoing SMS with health tips, reminders, and triage prompts.

(ii) **Case Escalation Workflow:** Routes complex or high-risk messages to a specialist dashboard for follow-up.

(iii) **Data Analytics Dashboard:** Displays real-time statistics such as active mothers, risk alerts, and message success rates.

4.3.2 System Design

The design followed a client-server architecture with three main interfaces:

(i) **Mother Interface:** Accessible through basic phones via SMS.

(ii) **AI Middleware:** Handles message scheduling, keyword detection, and data processing.

(iii) **Hospital Dashboard:** A web-based interface for staff to monitor cases, manage alerts, and generate reports.

The design tool we used was Figma. We used it to create wireframes, mockups, and interactive prototypes.

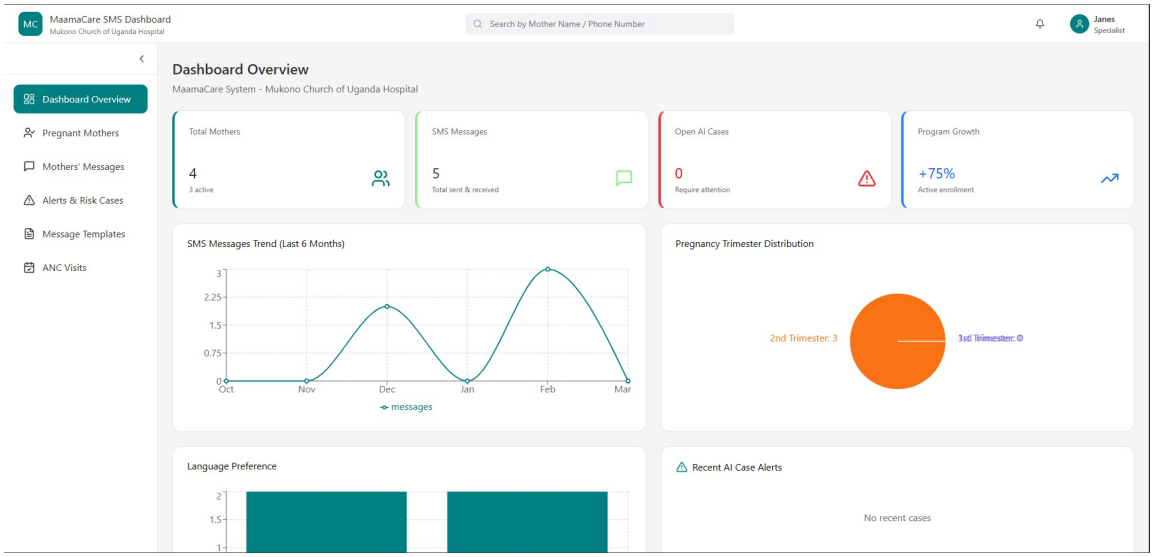


Figure 4: Hospital Dashboard Overview

4.3.3 System Development

Development followed the Agile methodology, emphasizing iterative prototyping and continuous refinement. The system will be developed using Python for the AI logic, Flash for the backend API, and a lightweight web framework Vite for the hospital dashboard.

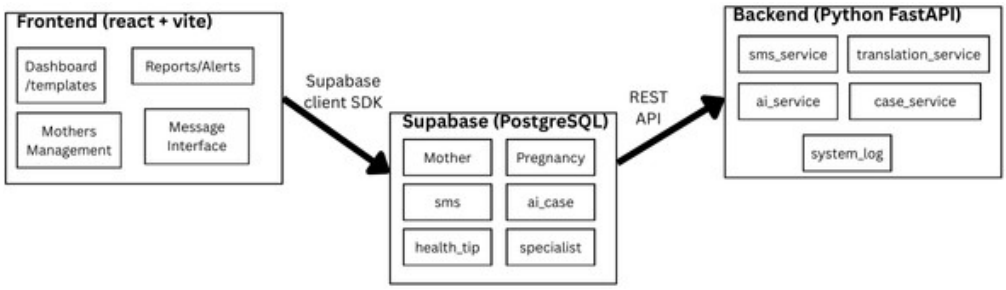


Figure 5: High-level system architecture

The AI module utilised a rule-based natural language processing (NLP) layer to detect danger signs in SMS (e.g., “bleeding,” “no movement,” “pain”). Detected red flags trigger automatic alerts to specialists. Our technology stack includes -

(i) Frontend: React Framework using Vite Bundler.

(ii) Backend: Python FastAPI

(iii) Database: Supabase using PostgreSQL

(iv) AI Services: OpenAI GPT 5.1 model

(v) SMS Provider: Africa’s Talking API

4.3.4 Testing Strategy

System testing took place in four stages:

(i) **Unit Testing:** Each module (communication, triage, dashboard) is tested independently.

(ii) **Integration Testing:** Ensured seamless data flow between AI engine, database, and dashboard.

(iii) **User Acceptance Testing (UAT):** Conducted with hospital staff to validate usability and functionality.

(iv) **Pilot Testing:** Deployed on a small sample of mothers to evaluate reliability, comprehension, and responsiveness.

5 PRESENTATION AND DISCUSSION OF RESULTS

This chapter presents and interprets the results of the MaamaCare system develop ment, covering the designed technology, its specifications and requirements, and the implementation and testing processes carried out. The results are drawn directly from the development activities described in the methodology.

5.1 Description of the Designed Technology

MaamaCare is an AI-enabled mobile communication system designed to bridge the maternal health information gap between Mukono Church of Uganda Hospital and pregnant mothers in its catchment area. The system operated primarily through SMS, enabling real-time, bidirectional communication with mothers regardless of their device type, internet access, or literacy level.

The system comprised three tightly integrated layers:

(i) The first was a mother-facing SMS interface accessible through any basic mobile phone. Mothers received SMS from the system operated through Africa's Talking API. SMS's were translated where necessary and reasoned over the content using the OpenAI GPT-5.1 model with guardrails which generated an appropriate health information.

(ii) The second layer was a web-based hospital dashboard built with React and Vite, providing health specialists with a real-time interface to register and manage maternal profiles, view SMS communication threads, monitor ANC visit schedules, manage AI-escalated risk cases, and access analytics on system-wide maternal health trends. A role-based access system distinguished between Admins, Specialists, Clerks, and Managers (Head Midwives), with Managers having read-only access for governance and quality oversight.

(iii) Drafted the justification of the study, SDG alignment, and national policy context.

(iv) The third layer was a Python FastAPI backend responsible for all server-side logic: sending SMS via Africa's Talking, running AI translation and health reasoning via OpenAI, storing and retrieving data from a Supabase PostgreSQL database, and executing background jobs for daily ANC reminders and missed visit detection.

Collectively, the system addressed the four core gaps identified in the preliminary study: the lack of automated communication, inconsistent follow-up for ANC visits, absence of real-time triage for high-risk mothers, and the burden of manual, repetitive administrative tasks on health staff.

5.2 Specifications

The technical specifications of the MaamaCare system were as follows:

Frontend

(i) Framework: React 18.3.1 with TypeScript 5.6.0.

(ii) Bundler: Vite 6.3.5.

(iii) UI Components: Radix UI, styled with Tailwind CSS v4.

(iv) Charts and Analytics: Recharts 2.15.2.

(v) State Management: React Hooks (useState, useEffect).

(vi) Data Layer: Supabase JavaScript Client SDK.

Backend

(i) Framework: Python FastAPI.

(ii) SMS Provider: Africa's Talking API (SDK v1.2.6), Sender ID: ATMHealth.

(iii) AI Engine: OpenAI GPT-5.1 model for health reasoning and Luganda–English translation.

(iv) Background Scheduling: APScheduler (AsyncIOScheduler) for daily ANC re minders.

(v) Interactive API Documentation: Swagger UI at /docs.

Database

(i) Provider: Supabase (PostgreSQL).

(ii) Authentication: Supabase Auth.

(iii) Security: Role-based access control (Admin, Specialist, Clerk, Manager); service role key used for backend operations.

5.3 Requirements

5.3.1 Functional Requirements

The following functional requirements were identified and implemented during the development of the MaamaCare system:

(i) The system shall allow health specialists to register pregnant mothers with personal details, pregnancy information, and next of kin contacts.

(ii) The system shall automatically generate ANC visit schedules based on the mother's Last Menstrual Period (LMP) at standard gestation intervals (4, 8, 12, 16, 20, 24, 28, 32, 36 weeks).

(iii) The system shall send automated SMS reminders to mothers one day before each scheduled ANC visit

(iv) The system shall allow specialists to mark ANC visits as completed or missed, with all actions logged to the respective table in the database for governance and audit purposes.

(v) The system shall allow mothers to log in via a phone number and OTP authentication flow and access their pregnancy information, ANC schedule, and message history through a mother-facing dashboard.

5.3.2 Non-Functional Requirements

(i) Accessibility: The system shall be accessible on basic feature phones via SMS, requiring no smartphone or internet connection on the mother's side.

(ii) Language Support: The system shall support bilingual communication in Luganda and English, with AI-powered translation maintaining clinical accuracy.

(iii) Security: All data shall be stored in a secured Supabase PostgreSQL database with role-based access control restricting data access to authorised personnel only.

(iv) Availability: Background jobs shall execute automatically on a daily schedule without requiring manual intervention from hospital staff.

(v) Scalability: The system architecture shall be designed to support expansion to additional health facilities beyond Mukono Church of Uganda Hospital.

5.4 Implementation Plan and Testing

This section presents the implementation status of each specific objective and also how the MaamaCare system was implemented.

5.4.1 Implementation Plan

For each objective, a table documents the activities carried out, the outputs produced, and the indicators demonstrating achievement. This is followed by a summary of outstanding tasks remaining for that objective.

Objective 1: Evaluate the existing communication workflows and challenges in maternal care at Mukono Church of Uganda Hospital

Activities Done	Output	Indicator	Progress (%)
Conducted structured interviews with several maternity ward professionals.	Documented needs assessment capturing existing communication gaps, workflow inefficiencies, and technology readiness.	Figure 2 and Figure 3 of this report shows sample responses received.	100%
Administered Google Forms questionnaire to maternity ward staff to collect quantitative data on communication frequency and follow-up time.	Quantitative dataset on staff communication patterns and technology adoption readiness.	Figure 2 and Figure 3 of this report shows sample responses received.	100%
Performed field observations of current patient record management and follow-up workflows.	Observation report identifying paper-EMR duplication, manual phone call burden, and absence of automated triage.	Notes taken	100%

Table 1: Summary of Research Activities and Evidence of Completion Objective 1

Objective 2: Design an AI-based system capable of delivering health tips and reminders through SMS in local languages

Activities Done	Output	Indicator	Progress (%)
Designed wireframes, mock-ups, and interactive prototypes using Figma covering the mother SMS interface and AI message flow.	Figma prototype of the full SMS communication interface and AIpowered reminder flow.	Figure 4 of this report shows a screenshot of the prototyped system.	100%
Defined AI reminder logic for ANC visits and trimester-based pregnancy stage messaging.	Documented AI reminder scheduling rules aligned to pregnancy trimesters and ANC visit schedule.	AI reminder logic was documented in the documentation of the system	60%
Integrated health message content in local languages into the SMS delivery pipeline.	SMS messages delivered in Luganda and English based on mother's language preference.		100%

Table 2: Summary of Research Activities and Evidence of Completion Objective 2

Objective 3: Develop a hospital dashboard for health specialists to manage escalated cases, monitor trends, and analyse maternal health data

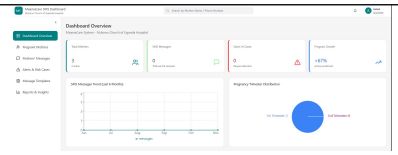
Activities Done	Output	Indicator	Progress (%)
Built the web-based hospital dashboard using React (Vite) connected to the Python FastAPI backend and Supabase database.	Operational hospital dashboard accessible to registered health specialists.		70%
Developed the data analytics module displaying real-time statistics including active mothers, trimester distribution, and SMS message trends over time.	Analytics dashboard panel with live visualisations of maternal health data and communication trends.	FIGURE TOBE ATTACHED	100%
Built the pregnant mother management module allowing specialists to register, view, and update maternal profiles.	Functional mother management interface enabling registration and profile tracking.	FIGURE TOBE ATTACHED	90%

Table 3: Summary of Research Activities and Evidence of Completion Objective 3

5.4.2 What Is Left To Be Done

The following tasks remain outstanding across the project objectives and are to be completed before the final system deployment and submission:

AI SMS Communication System

(i) Implementation of the ability to be able to receive SMS's.

(ii) Complete end-to-end testing of the AI conversational rules covering all identi fied maternal query scenarios.

(iii) Review all AI response logic with a health professional to verify clinical accuracy of automated replies.

Hospital Dashboard

(i) Complete the reports generation module to allow specialists to export maternal health data and communication summaries as PDF or CSV.

(ii) Finalise the case prioritisation workflow so that high-risk cases are visually ranked and colour-coded on the dashboard.

(iii) Complete end-to-end encryption audit of all data in transit between the SMS provider, backend API, and database.

(iv) Implement an automated database backup schedule to prevent data loss during the pilot phase.

(v) Test data integrity under concurrent usage scenarios with multiple specialists accessing the system simultaneously

System Evaluation and User Acceptance

(i) Complete the full pilot testing phase with a larger sample of registered mothers across different literacy levels and language preferences.

(ii) Present findings to hospital administration

6 EVALUATIONS

This chapter evaluates the MaamaCare system against its intended objectives, discusses the limitations encountered during the technology's design and implementation, documents problems encountered during the development process, and provides recommendations and directions for future research.

6.1 Evaluation of the System Against Objectives

The MaamaCare system was evaluated against each of the five specific objectives of the study. The evaluation considered both the degree of implementation achieved and the functionality demonstrated during testing.

The first objective, to evaluate existing communication workflows and challenges at Mukono Church of Uganda Hospital, was fully achieved. Structured interviews and questionnaire data collected from health professionals confirmed the absence of digital communication systems, the burden of manual follow-up, and the readiness of staff for AI-assisted tools. These findings directly informed all subsequent system design decisions and provided the empirical grounding for the system's functional requirements.

The second objective was partially achieved. The AI communication engine, translation service, and Africa's Talking SMS integration were all implemented and individually tested. Health tips were categorised by trimester, language, and topic, and the AI pipeline for inbound message processing was designed and partially integrated. Full end-to-end integration of the inbound SMS webhook with the AI pipeline remained the primary outstanding task at the time of this report.

The third objective, to develop a hospital dashboard for case management, trend monitoring, and maternal health analytics, was largely achieved. The specialist dashboard was fully functional with live data from Supabase, including mother management, ANC tracking, SMS communication history, and analytics. The Manager Dashboard with governance KPIs and specialist performance metrics was also implemented. PDF/CSV export functionality for reports was identified as a remaining feature as well as case escalation.

Finally the objective to evaluate the feasibility and user acceptance of the system is still in the works. Initial UAT with hospital staff has not been done yet.

6.2 Limitation of the Technology

Although the MaamaCare system was successfully developed and tested as a prototype, several technological limitations were encountered during the implementation of the project.

One of the main limitations involved the SMS communication functionality. While the system was able to successfully send automated SMS messages to mothers using the SMS gateway, it was not possible to fully implement two-way SMS communication where mothers could send messages directly to the system. This limitation was largely due to constraints and configuration requirements associated with the SMS service provider, which restricted the ability to reliably receive inbound SMS messages during the development phase.

Another limitation relates to the evaluation environment of the system. The system was tested primarily within a controlled development environment rather than in an operational hospital setting. As a result, the project did not include real-world testing with healthcare workers or pregnant mothers, which would have provided more comprehensive feedback regarding usability, effectiveness, and practical integration within hospital workflows.

Additionally, the artificial intelligence assistant relies on external AI services for generating responses. This dependency introduces potential constraints such as internet connectivity requirements, API usage limits, and operational costs that could affect large-scale deployment of the system in low-resource healthcare environments. Language support also remains limited in the current implementation. While the system demonstrates the ability to communicate in English and Luganda through the AI interface, further development would be required to ensure accurate localization and broader accessibility for users who speak other local languages.

Despite these limitations, the prototype successfully demonstrates the feasibility of combining SMS communication with artificial intelligence to support maternal health information delivery. These limitations provide opportunities for future improvements and further research.

6.3 Problems Encountered

The following technical and operational challenges were encountered during the development of the MaamaCare system:

(i) **Supabase and httpx Compatibility Issue:** A critical compatibility conflict was encountered between Supabase Python client 2.3.0 and httpx 0.24.x, causing a TypeError at startup due to an unexpected proxy keyword argument. This was resolved by unsetting proxy environment variables at module import time

(ii) **Database Schema Mismatches:** Column name mismatches were discovered between the backend service code and the deployed Supabase schema. These were identified and corrected in both the service layer and the database queries.

(iii) **Africa's Talking TIN Registration Delay:** Obtaining a registered shared shortcode from Africa's Talking to be able to receive inbound SMS required submission of a Tax Identification Number (TIN) and supporting documentation, which introduced delays in the timeline. This deferred full two-way SMS testing to a later phase of the project.

6.4 Recommendations and Future Research

Based on the findings, limitations, and technical lessons of this project, the following recommendations and directions for future research are proposed:

(i) **Complete the AI Pipeline Integration:** The highest priority remaining task is wiring the inbound SMS webhook to the full AI pipeline, translation, reasoning, case creation, and automated reply. This is essential before the

system can function autonomously as intended and should be the immediate next development milestone.

(ii) **Validating Luganda Translation with Clinical Linguists:** A formal validation study should be conducted involving native Luganda speakers and maternal health professionals to assess the clinical accuracy and cultural appropriateness of AI-generated Luganda health messages. This is critical for ensuring that SMS content is safe, understandable, and trusted by mothers.

(iii) **Expand Language Support:** While Luganda and English are the current languages, Uganda has over 5 local languages. Future versions of the system should incorporate automatic language detection and support for additional languages including Runyankore, Lusoga, and Acholi to extend the system's reach to other regions.

(iv) **Scale to Additional Health Facilities:** The system was architected with multi facility scalability in mind. Future research should evaluate the deploy ment of MaamaCare in multiple health facilities in Uganda, assessing whether the impact of the system on maternal outcomes generalizes beyond the context of the Mukono district.

(v) **Integrate Predictive Analytics:** Future work should explore the use of aggregated maternal data collected by MaamaCare to train predictive models for early identification of high-risk pregnancies, enabling proactive intervention before complications arise.

6.5 Conclusion

This project presented the design and development of MaamaCare, an AI-powered SMS maternal health support system aimed at improving communication between healthcare providers and pregnant mothers. The system was developed to address the challenge of limited access to maternal health information, particularly for mothers who rely on basic mobile phones rather than smartphones.

The MaamaCare system integrates automated SMS health education, an AI-powered maternal health assistant, and a hospital monitoring dashboard that allows healthcare workers to track communication and manage maternal health information. Through the use of SMS technology, the system is able to deliver important pregnancy-related information and antenatal care reminders directly to mothers using basic feature phones.

The system was developed using an Agile development methodology, which allowed iterative design, implementation, and testing of system components. The resulting prototype successfully demonstrated core functionalities including auto mated SMS messaging, AI-assisted maternal health guidance through the mother dashboard, and a monitoring interface for healthcare staff.

Although the system has not yet been deployed in a real hospital environment, the prototype demonstrates the potential of integrating artificial intelligence and mobile communication technologies to improve maternal health information access in low-resource settings. With further development, real-world testing, and improved

system capabilities, MaamaCare could contribute to enhancing maternal healthcare communication and supporting healthcare providers in delivering timely information to expectant mothers.

Future work may include implementing full two-way SMS communication, expanding language support, integrating with hospital electronic medical record systems, and conducting pilot deployments within healthcare facilities to evaluate the system’s practical impact.

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8 APPENDICES

Appendix A: QUESTIONNAIRE

Section A: Clinical Challenges & Mother Care

1. **Top Health Issues:** What are the three most common medical issues or risk factors you observe among pregnant mothers at Mukono Hospital? (e.g., high blood pressure, poor diet, missing ANC visits, etc.)
2. **Critical Warning Signs:** What specific, urgent warning signs or keywords (e.g., "bleeding," "severe headache," "no movement") should immediately flag a communication for human intervention?
3. **Communication Barrier:** What's the biggest barrier preventing mothers from following ANC advice?
4. **Technology Access:** Do most expectant mothers you interact with have their own personal phone, or do they share one with family members?

Section B: Current System & Staff Workflow

5. **Current Record Keeping:** How do you currently record patient information?
6. **Case Escalation Process:** When a mother calls with a serious problem outside her visit, what are the usual steps taken by staff?
7. **Time on Routine Tasks:** Roughly how much time per day do staff spend on routine or repetitive communication (reminders, common questions)?
8. **Staff Roles for Communication:** Which staff handle communication and data entry the most? (e.g., midwives, nurses, records officers)

Section C: AI, Technology Requirements & Validation

9. **Preferred Channel:** Which communication channel is generally more reliable and accessible for the majority of mothers in the Mukono area?
10. **Follow-Up Procedures:** When a mother misses a scheduled ANC visit, how does the hospital currently handle follow-up, if any at all?
11. **Tip Frequency:** How often should routine health tips be sent to a mother during her pregnancy?
12. **Key Data for Triage:** What's the most critical piece of information you need to see first when reviewing an escalated case? (e.g., gravida/parity, distance to hospital, medical history, etc.)
13. **Trust in AI:** What's your main concern or required feature for you to trust an AI system to assist in triage?